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THE RELATIONSHIP BETWEEN MOUNTAIN PINE BEETLE INFESTATIONS AND TYPES OF HOST MATERIALS

1938 Investigations

by

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Forest Insect Laboratory
Coeur d'Alene, Idaho
February 8, 1939

Dr. F. C. Craighead

Washington, D. C.

Dear Dr. Craighead:

There are enclosed two copies of a laboratory report on the relationship between mountain pine beetle infestations and types of host materials, by Mr. Bedard. The extra copy is intended for whatever disposition you may desire.

This report is to be considered as a progress statement of the data that we have accumulated during the past two or three seasons. These data depict conditions as encountered, which can perhaps be taken as an indication of final results. However, we realize that a great deal more data than we now have will need be made available to this study before final conclusions can be drawn.

Your comments and suggestions will be appreciated.

Respectfully yours,

JAMES C. EVENDEN
Senior Entomologist

Enclosures

cc to:
Mr. Miller
Mr. Keen
Dr. Beal

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The mountain pine beetle attacks several different types of western white pine host material, any one of which may be so abundant during the course of an infestation that it becomes a dominant factor which must be evaluated in order to determine the importance of the outbreak. Such a determination has been particularly difficult in the past because the volume of mountain pine beetle brood produced in different types of decadent host material as compared with normal trees has never been properly determined.

During the past three seasons practically all of the different types of host material were examined by the infestation study crew on the Coeur d'Alene National Forest. Unfortunately, inability to move CCC crews very far from their base camp made it possible to sample only a few local areas, so that data presented in this report are not conclusive and represent conditions only within the areas studied. All material was examined by taking a half-square-foot sample on four sides of the tree at ten-foot intervals and recording the number of mountain pine beetle broods, parent emergence holes, attacks, inches of egg gallery, parasites, predators, wood borers, square inches of secondary bark beetle, wood borer and woodpecker work.

In this report five types of decadent host material have been recognized, namely, road slash and cull logs, logging slash and cull logs, windfalls and physically injured trees, fire-scorched trees, and standing trees weakened by disease. Each of these types will be considered separately.

Road Slash

In the areas examined by the infestation study crew all white pine trees felled in the process of road construction were cut into logs and sold. This left only tops and cull logs along most new roads, and during 1937 and 1938 left no material at all which was suitable for examination. Table I shows conditions in both 1935 and 1936 road slash. The 1 material was attacked during 1935 and examined at the time of emergence in 1936. The 1936 material was attacked and examined during 1936, and as these logs were removed following their examination, only two culls were left for reexamination at the time of emergence during 1937.

TABLE I
Conditions in Road Slash

Year of attack	Year of exam.	Bark surface	Average per square foot of bark: Brood	Attacks	Parasites	Predators	Secondary work	Wood borer work
		sq.ft.	no.	no.	no.	no.	sq.in.	sq.in.
1935	1936	2567	0.7	0.6	0.6	3.2	79.0	0.6
1936	1936	2110	56.1	1.5	0.7	1.2	12.3	3.7
1936	1937	124	1.2	1.6	0.4	0.9	81.2	8.4

Table I shows that e was a negligible amount of emergence from the 1935 material, and indications are that there would have been but a sligh emergence from the 1936 material in spite of the rather high potential apparent in the early developmental stages. The cause of this high mortality in road slash is not exactly known. It is apparent, however, that wood borers and secondary bark beetles, particularly Ips vancouveri

and Pityogenes fossifrons, destroy a large part of the available bark surface. In addition to the broods destroyed by parasites, predators, and robbers, that is, secondary bark beetles and wood borers, there is undoubtedly some mortality in this material, particularly on the tops of logs, from overheating during the summer.

From available data shown in table I the indications are that road slash in the two areas sampled was given over mostly to secondary bark beetles and wood borers and did not threaten as a potential source of mountain pine beetles, nor did it serve as a source of beneficial insects. Road slash has been examined, however, which contained abundant broods of the mountain pine beetle at the time of emergence, and it is believed that all road slash should be watched carefully.

Logging Slash

The logging slash examined in the study comprised tops, cull logs, and stumps. The area examined in 1936 was an experimental clear-cutting area in which the slash was scattered. In 1937 another experimental area was used, in which a heavy residual stand was left and the slash was piled and burned. No logging slash was available for study during 1938. The two areas examined, however, represent the approximate extremes in shade following the logging of a white pine stand. Table II shows the data from these two examinations.

TABLE II
Conditions in Logging Slash

Year of attack	Year of exam.	Bark surface	Average per square foot of bark: Brood	Attacks	Parasites	Predators	Secondary work	Wood borer work
		sq.ft.	no.	no.	no.	no.	sq.in.	sq.in.
1935	1936	1210	0.1	0.08	0.09	0.04	1.4	0.06
1937	1937	3444	2.8	0.2	0.2	0.6	34.2	0.06

The data shown in table II indicate quite clearly that the logging debris examined in this study was decidedly unfavorable for the development of the mountain pine beetle. The material examined during 1936 was unshaded, and was apparently unfavorable for secondary bark beetles and wood borers as well. The shaded material examined in 1937, however, did produce a quantity of secondary bark beetles.

Windfalls and Physically Injured Trees

The first two classes of host material represent that type which is subject to rapid drying owing to the fact that it has been severed from the roots. Windfalls, lightning-struck trees, other physically injured trees, trees scorched by fire, and trees weakened by disease represent another class in which the trees maintain a full or partial root system for some time and thus provide some moisture to the developing broods. As there are differences in these various types, this class has been divided into three groups, namely, windfalls and physically injured trees, fire-scorched trees, and trees weakened by disease.

Table III shows the data secured from windfalls and broken-topped

trees. During the past three years there has been a scarcity of material of this nature on the Coeur d'Alene Forest, so that for the purpose of securing a better average the trees from both seasons' work have been grouped.

TABLE III

Comparison of Windfalls and Broken-topped Trees with Standing Trees

Type of mat.	Trees	Bark surface	Average per square foot of bark: Brood	Attacks	Parasites	Predators	Secondary work	Wood borer work	Woodpecker work
	no.	sq.ft.	no.	no.	no.	no.	sq.in.	sq.in.	sq.in.
Weakened trees	10	2,078	25.4	2.1	3.8	4.3	35.2	1.9	10.6
Standing trees	222	45,159	29.9	5.2	2.8	1.3	11.8	3.2	5.6

Table III bears out the belief that broods in windfalls are almost as abundant as those in standing trees even though there are more than twice as many attacks in standing trees, and parasites, predators and robber work are decidedly more abundant in windfalls. It is obvious, therefore, that this type of host material is an important factor in infestations of the mountain pine beetle. With few attacks, this insect can produce almost as abundant progency in windfalls as more than twice the number of attacks in standing trees.

It might be thought that the equality of the brood in spite of the difference in attack is due to the fact that less parent emergence occurs in the windfalls because of less competition for bark surface. There is, however, a proportionate emergence of parent beetles from both types of material. In the windfalls the number of parent emergence holes were 63 percent of the

number of attacks, while in standing trees they were 57 percent of the attacks.

Relative to egg gallery construction, there were 35.7 lineal inches per square foot in windfall material and 78.0 inches in standing trees. Dividing this by the number of attacks, there were 17.4 inches per gallery in windfalls and ~~18.9~~ 15.0 inches per gallery in standing trees.

Fire-scorched Trees

During the three years of this study, only one small burned area was available, in which a total of 17 scorched trees were felled and examined. These trees had been left on top of a low ridge to regenerate surrounding areas which had been clear cut and burned broadcast. Table IV shows the data from these trees.

TABLE IV
Condition in Fire-scorched Timber

Year of attack	Year of exam.	Bark surface	Average per square foot of bark: Brood	Attacks	Parasites	Predators	Secondary work	Wood borer work	Woodpecker work
		sq.ft.	no.	no.	no.	no.	sq.in.	sq.in.	sq.in.
1936	1937	3.291	0.01	0.3	0.01	1.0	42.8	0.9	0

Table IV shows that the trees in this particular area were of no great importance as potential sources of mountain pine beetle infestation. This does not necessarily indicate that all fire-scorched white pine trees produce such meager broods. Additional data of a similar nature representative of other types of burned areas are necessary before conclusions can be made.

Trees Weakened by Disease

This class comprises for the most part those trees which have been damaged by root fungi, thought to be primarily one fungus, Armillaria mellea. Unfortunately, owing to the type of damage which is the habit of this fungus, it is sometimes impossible to ascertain the presence of the disease without exposing a large portion of the root system. Even then, it is difficult to make a comparative evaluation of the injury because of the difference in the progressive stages of rot development. However, these infected trees undoubtedly represent a low resistance class containing a wide variety of conditions, from trees with practically the entire root collar infected to those in which the presence of the fungus can be found only after digging well out along the lateral roots.

During the 1938 season a cooperative study was undertaken between the Northern Rocky Mountain Forest and Range Experiment Station, the University of Idaho Forestry College, and the Bureau of Entomology and Plant Quarantine Forest Insect Laboratory at Coeur d'Alene, for the purpose of determining something of the importance of the root rot problem in western white pine. The main report is being written by Dr. John Ehrlich, professor of forest pathology at the University of Idaho, but a few of the pertinent data from insect-infested trees are included in this report.

Table V shows the data from nine trees examined during 1938 which were considered in such weakened condition that their final resistance was overcome by secondary bark beetles. All nine trees were infected with root rot.

Stump of mountain pine beetle-killed western white pine excavated to determine presence and abundance of root rots.

TABLE V
Insect Abundance in Severely Weakened Trees

Trees	Bark surface	Average per square foot of bark: D. m. brood	D. m. attacks	D. m. gallery	Secondary work	wood borer work
no.	sq.ft.	no.	no.	in.	sq.in.	sq.in.
9	676	0	0.02	1.1	50.8	5.4

It is obvious that certain white pine trees are in a severely pathological condition, but whether this condition results from infection by Armillaria or whether the root rot itself is secondary like the beetle attack, has not yet been demonstrated.

Table VI shows the percent infection in beetle-infested and green trees.

TABLE VI
Prevalence of Infection in Green and Beetle-infested Trees

Trees	Trees examined	Trees infected	Trees uninfected	Percent infected
	no.	no.	no.	percent
Green	76	10	66	13.1
D. m. attacked examined 1937	99	36	63	36.4
D. m. attacked examined 1938	130	49	81	37.6

It would appear from table VI that there is a slight preference shown by the mountain pine beetle for diseased trees because if no preference were shown, the diseased beetle-killed trees would be in the same percentage as in the green stand. It is believed, however, that this does not represent

true conditions, as shown in table VII where the trees of the current season's attacks are separated from those attacked during the previous season.

TABLE VII
Prevalence of Infection in Current and Previous Season's Attack

Year of attack	Year of examination	Trees examined	Trees infected	Trees uninfected	Percent infected
		no.	no.	no.	percent
1937	1938	61	37	24	60.6
1938	1938	69	12	5	17.3

Here it is seen that infection is not nearly as apparent when the trees are examined shortly after attack as it is when the fungus has had more time to develop in an unresistant tree. Rapidity of vegetative growth is one of the characteristics mentioned by pathologists for the Armillaria fungi. It is quite conceivable, therefore, that with the apparent prevalence of these fungi in white pine duff, infection can even occur following beetle attack, and with rapid growth the mycelial fans would be common one year after beetle attack. In any event, the percentage of infection in trees examined the same season in which they were attacked is nearly that found in green timber, particularly when one considers the difficulty of determining the presence of the fungus in green trees without injuring them. Thus, with the less intensive examination of green trees, it is believed that the percentage of infection in green timber would be higher than indicated by the figure in table VI, and that there is no preference shown by the mountain pine beetle for infected trees.

There are, however, disease-weakened trees within a western white pine stand which serve as host material for the mountain pine beetle. Table VIII shows the abundance of mountain pine beetle broods and prevalence of weevils and wood borers according to the amount of root injury. Percentage of root injury was determined by the number of main lateral roots and percent of root collar destroyed by the fungi.

TABLE VIII
Abundance of Attacks, Broods, Weevils and Wood borers According to the Percentage of Root System Destroyed

Root injury percent	Trees examined: no.	Weevils present: Trees: no.	Weevils present: Percent	Wood borers present: Trees: no.	Wood borers present: Percent	Attacks per sq.ft.: no.	Brood per sq.ft.: no.
0	35	14	40.0	9	25.0	4.4	33.1
1-50	26	10	38.5	6	23.1	3.4	21.0
51-100	30	11	36.7	3	10.0	2.0	18.8
Total infected	56	21	37.5	9	16.0	2.7	19.8

It is apparent in table VIII that the density of mountain pine beetle attack and abundance of broods depend on the degree of infection. Although the broods are less abundant in infected trees, the attacks are also less dense and the ratio of increase remains approximately the same for infected (3.6 to 1) and uninfected (3.8 to 1) trees. Thus, trees infected with root rot represent an important type of host material in western white pine stands. Not only are they important from the standpoint of maintaining mountain pine beetle infestations, but they also serve to complicate the data secured from forest insect surveys relative to the importance of any given infestation. Table IX shows the various ratios of increase which

occur as a result of an exchange of insects between the various types of host material. These ratios have been based on the 1938 data only and merely serve to demonstrate the variations which can be expected.

TABLE IX
Ratio of Increase in Exchange of Insects Between Various Types of Host Material

Emerge from		Attack	
number	Type of host material	number	Type of host material
1	Infected tree	2.2	Standing uninfected trees
1	Windfall	2.8	Standing uninfected trees
1	Infected tree	3.6	Infected trees
1	Standing uninfected tree	3.8	Standing uninfected trees
1	Infected tree	4.7	Windfalls
1	Windfall	4.7	Infected trees
1	Windfall	6.0	Windfalls
1	Standing uninfected tree	6.1	Infected trees
1	Standing uninfected tree	7.8	Windfalls

To take one example, it is seen that the emerging beetles from one green tree are sufficient to infest 3.8 green trees, 6.1 infected trees, and 7.8 windfalls on the basis of the 1938 data, providing the trees are of comparable infested bark surface, attacks are of the same density, there is no flight mortality, and other important factors are similarly equal. Fortunately, this was not the case, as the attacks during 1938 were more dense than during the previous two seasons. Table IX does serve to show, however, that the type of host material infested may cause a considerable change in the number of infested trees within an area, even though there has been no great increase or decrease in mountain pine beetle population.

Attraction of Host Material

Unfortunately, no data are available relative to the importance any of these host materials in attracting beetles to adjacent green st Information of this nature is necessary in order to present a true pic of the importance of any of these materials.

SUMMARY

Several different types of host material are attacked by the mo tain pine beetle. Thus in order to determine the importance of any in tion it is necessary to make a proper evaluation of the various host m

In the material sampled by this study indications are that road and cull logs, although potentially capable of abundant broods, did no threaten as a source of mountain pine beetles in the areas examined. available bark surface is utilized mostly by secondary bark beetles an borers.

Available data from two small areas indicate that logging debri unfavorable for the development of the mountain pine beetle. This hos material is quite similar to road slash in producing abundant broods o secondary bark beetles.

Data secured to date indicate that mountain pine beetle broods windfalls are almost as abundant as those in standing trees even thoug there are more than twice as many attacks in standing trees. Parasite predators and robbers are decidedly more abundant in windfalls. This of host material is an important factor, therefore, in infestations of mountain pine beetle.

In one small burned area examined, the data indicate that the trees in this particular area were of no great importance as potential sources of mountain pine beetle infestation.

Trees infected with root rots, although apparently not preferred, are attacked by the mountain pine beetle. Broods in these trees are less abundant than in standing trees, but as the attacks are also less dense, the ratio of increase is approximately the same. The variation in density of attack and broods produced in different types of host material make it difficult to evaluate an infestation on a tree-per-acre basis.

No data are available concerning the attraction of the various types of material and the resultant infestation in adjacent timber.

Respectfully submitted,

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